FIG. 1

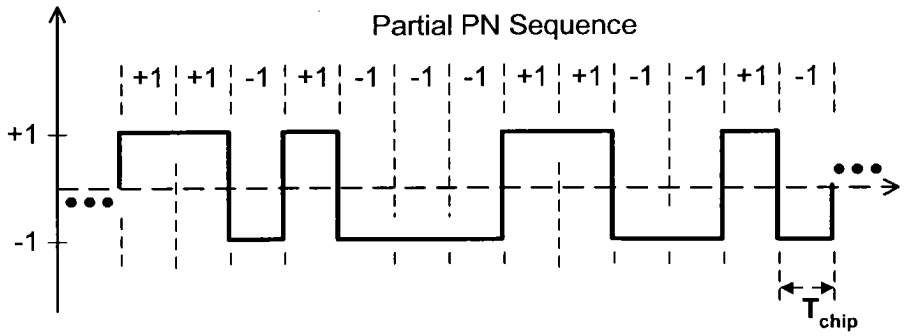



FIG. 2

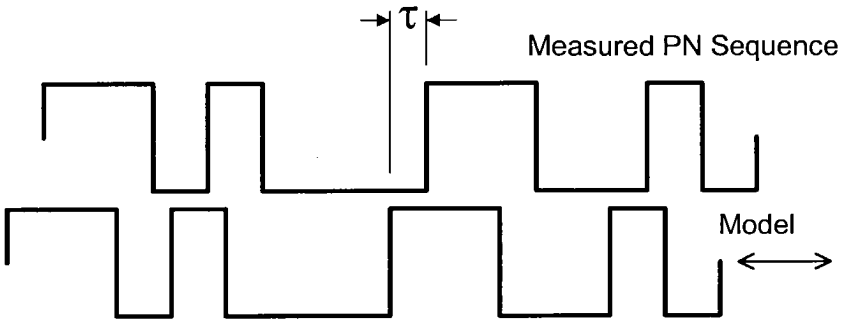
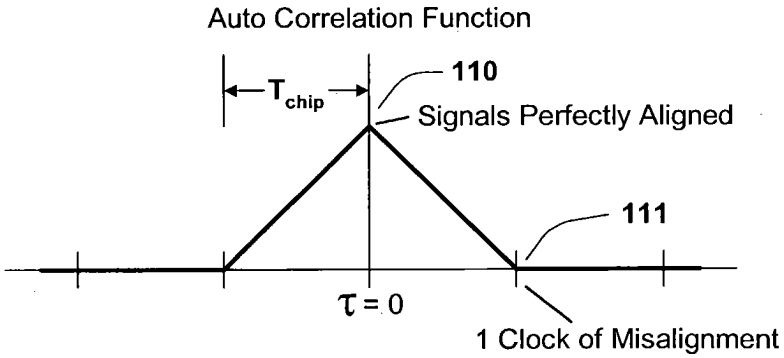



FIG. 3



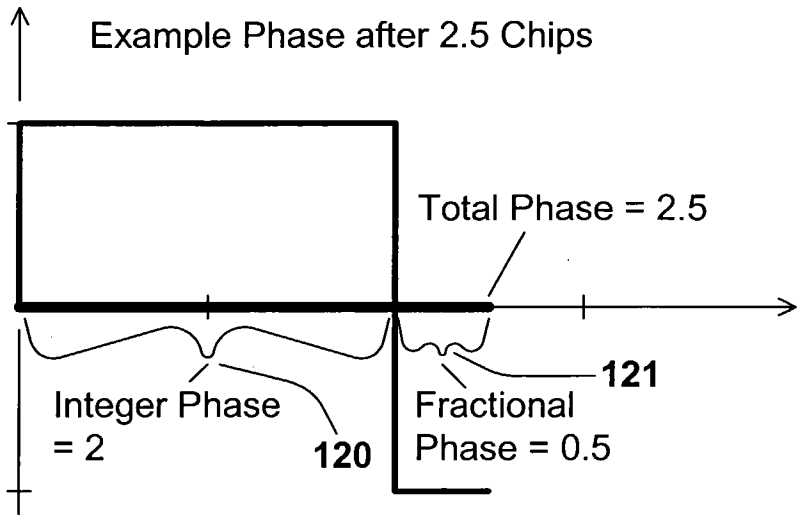

Example Phase after 2.5 Chips
Total Phase = 2.5
121
Integer Phase
= 2
120
Fractional
Phase = 0.5

FIG. 4

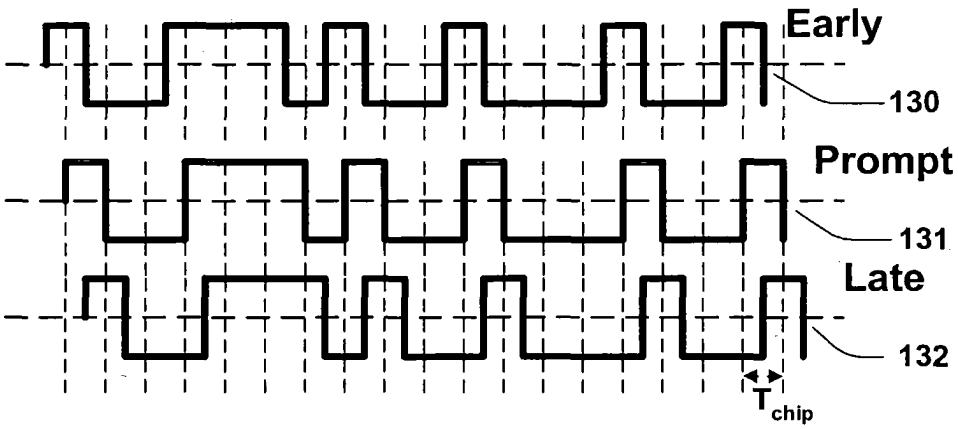



FIG. 5A

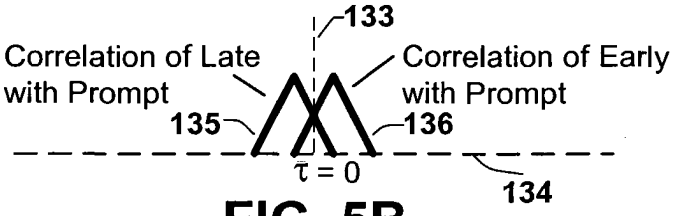



FIG. 5B

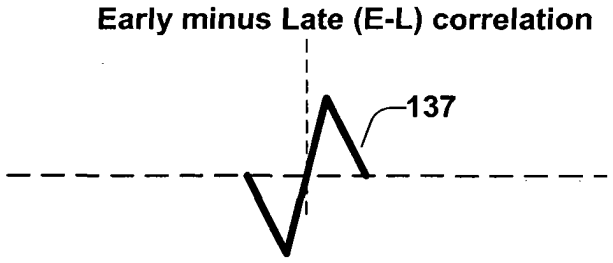



FIG. 5C

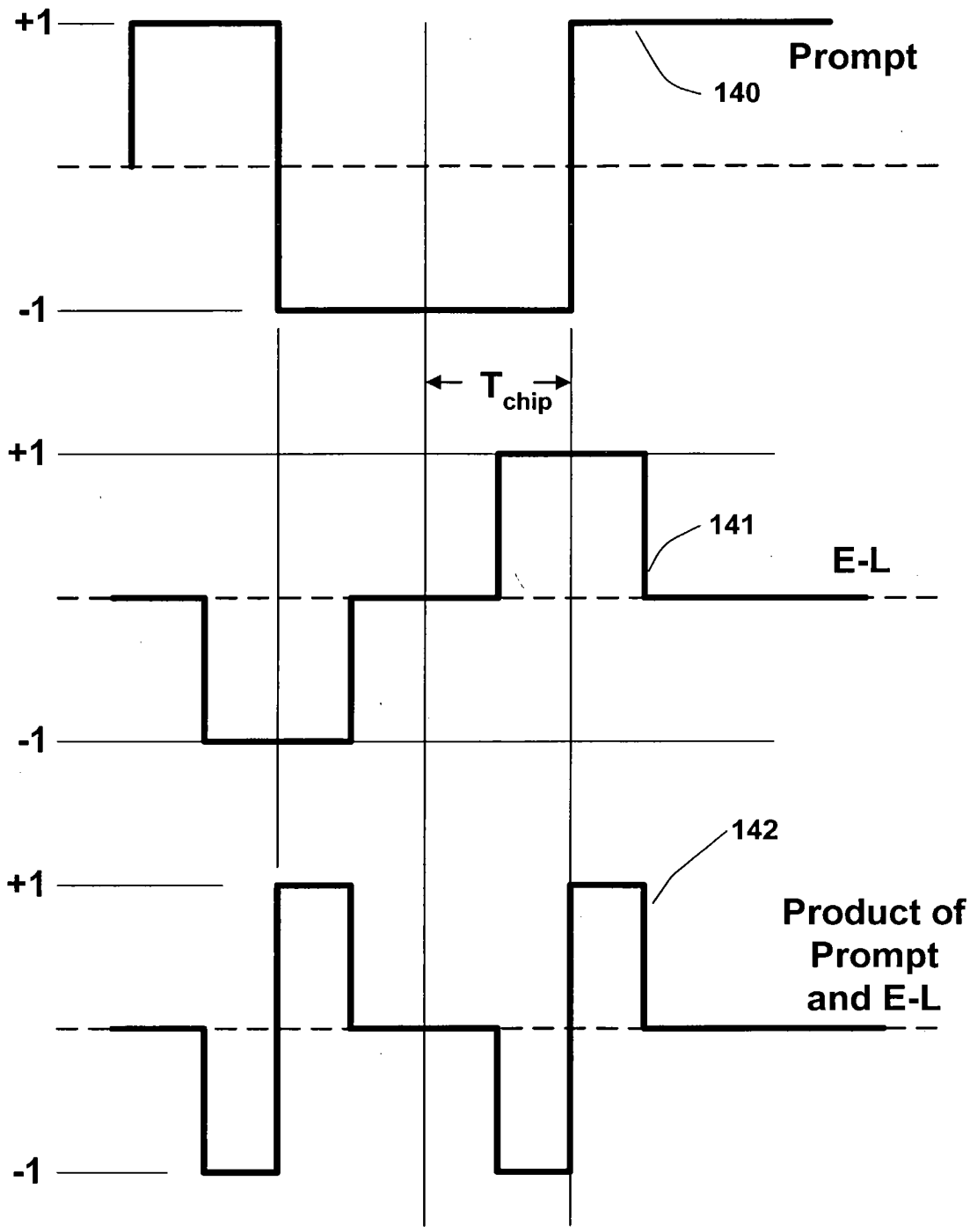



FIG. 6

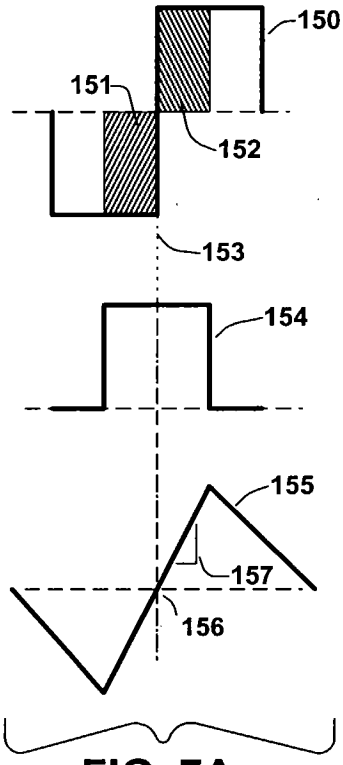



FIG. 7A

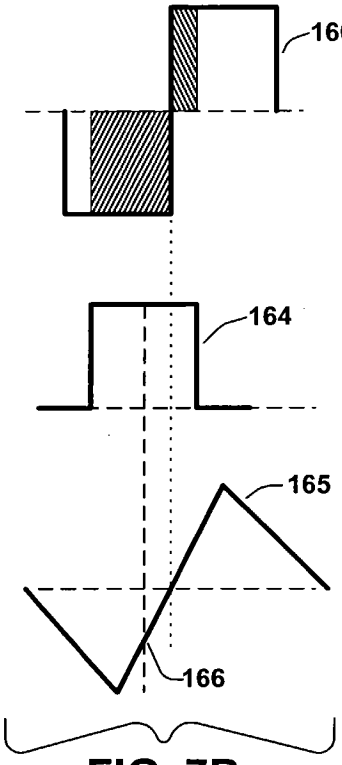



FIG. 7B

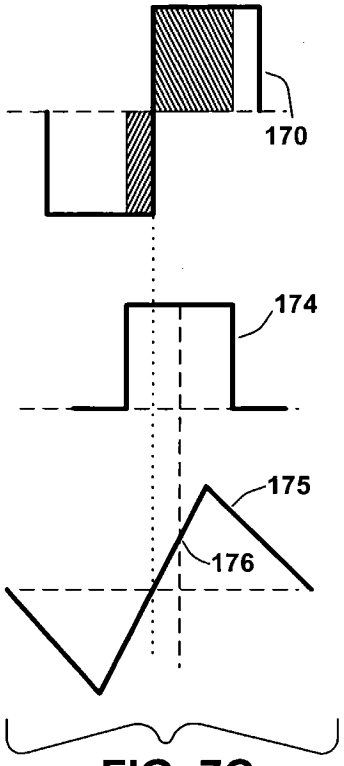



FIG. 7C

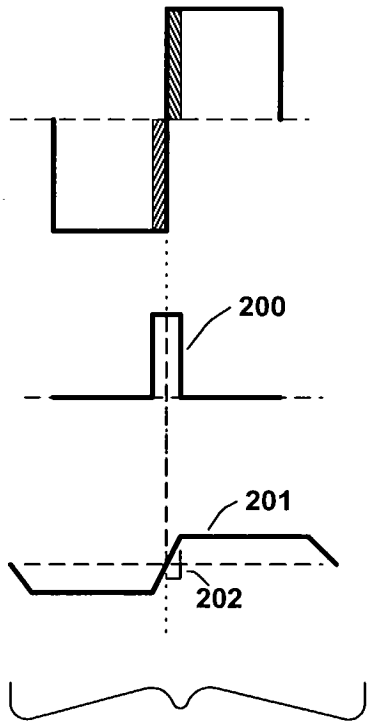



FIG. 8A

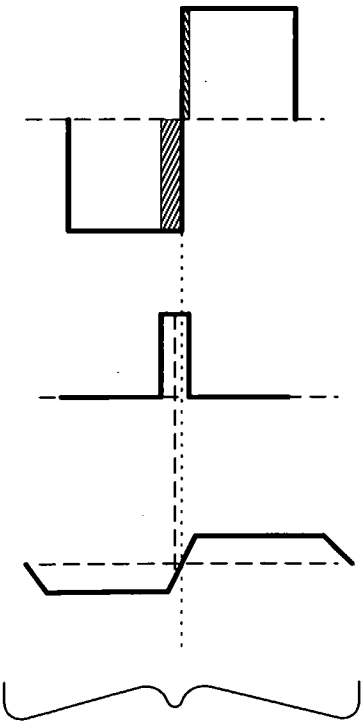


FIG. 8B

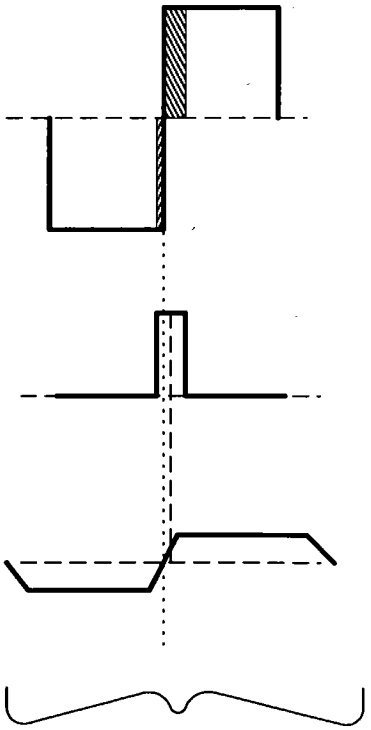


FIG. 8C

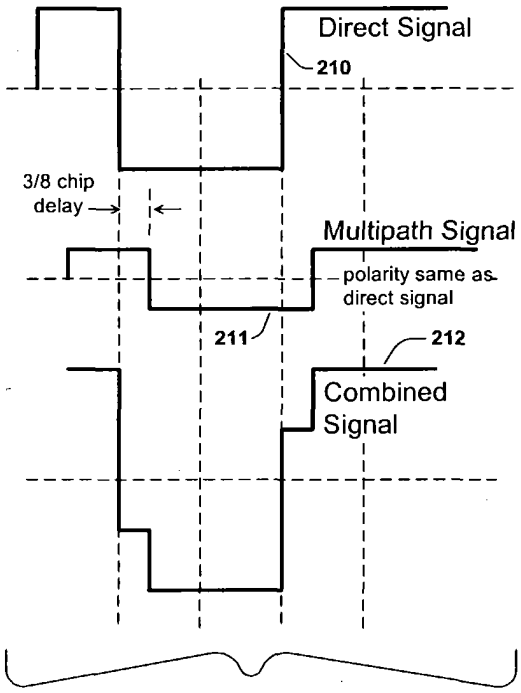



FIG. 9A

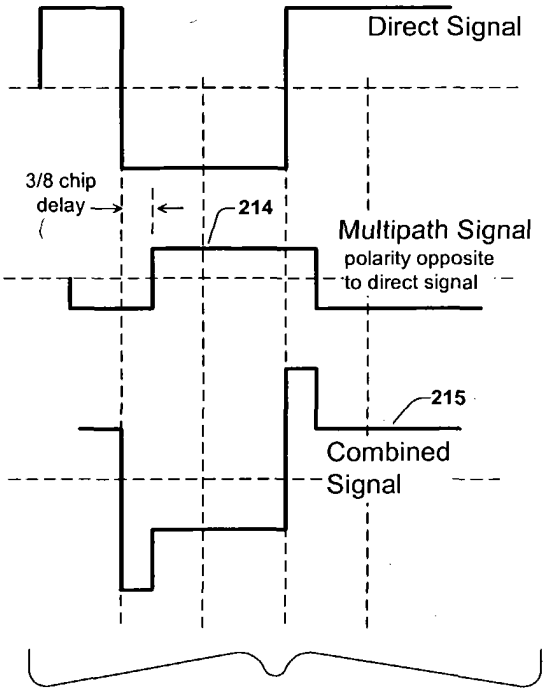



FIG. 9B

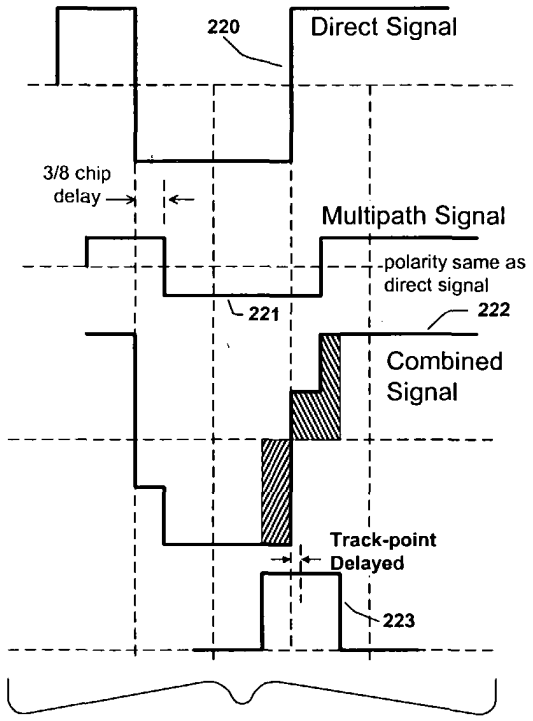



FIG. 10A

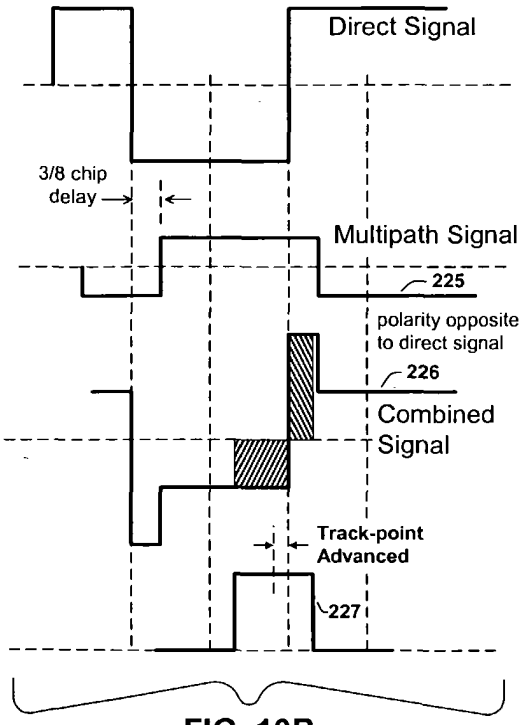



FIG. 10B

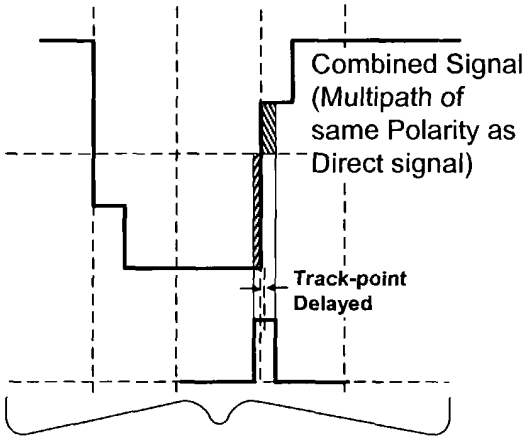



FIG. 11A

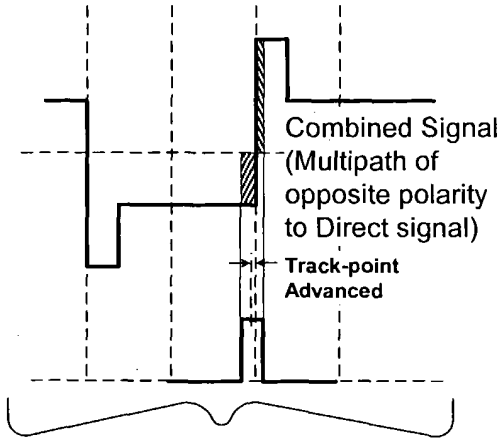



FIG. 11B

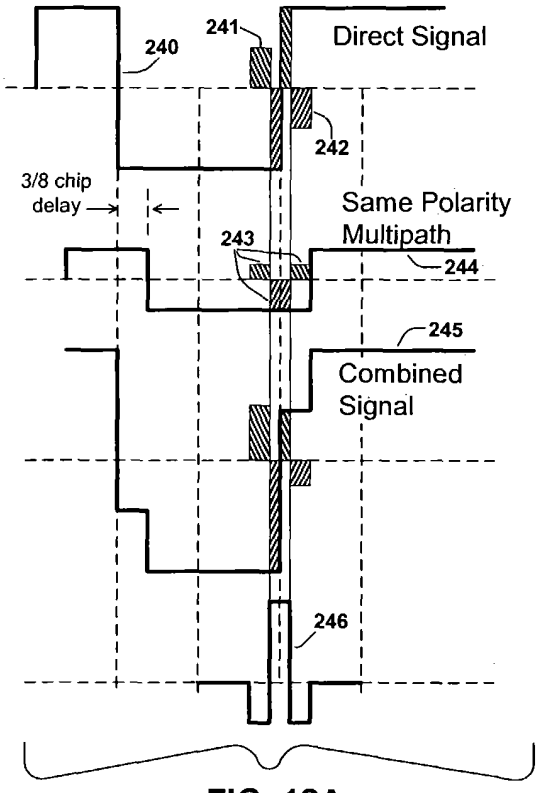



FIG. 12A

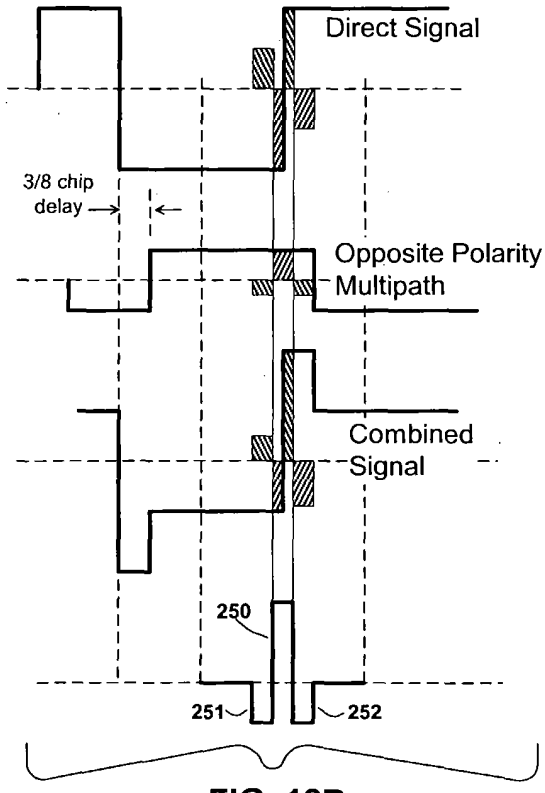



FIG. 12B

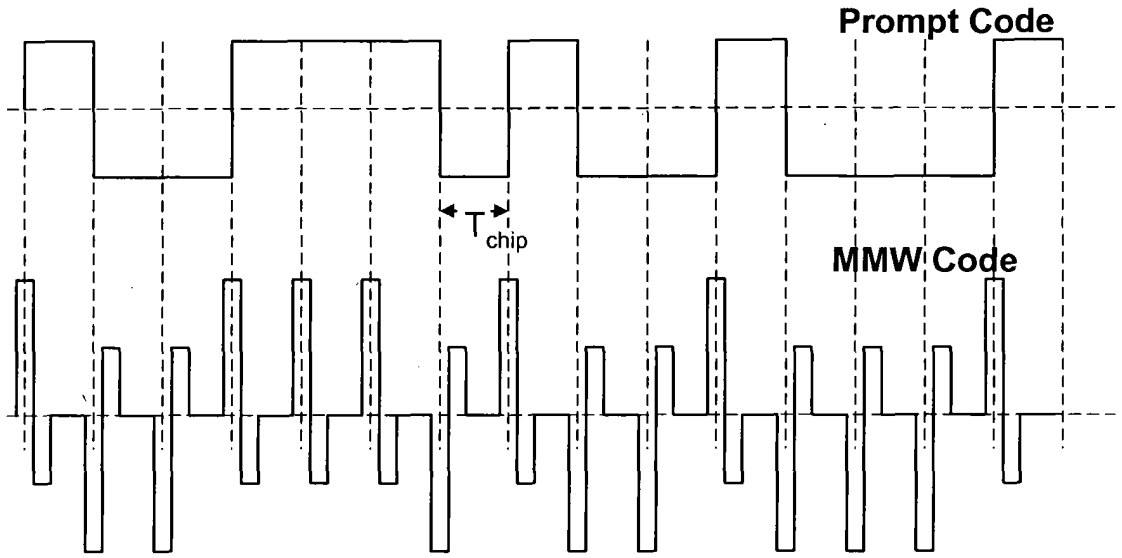
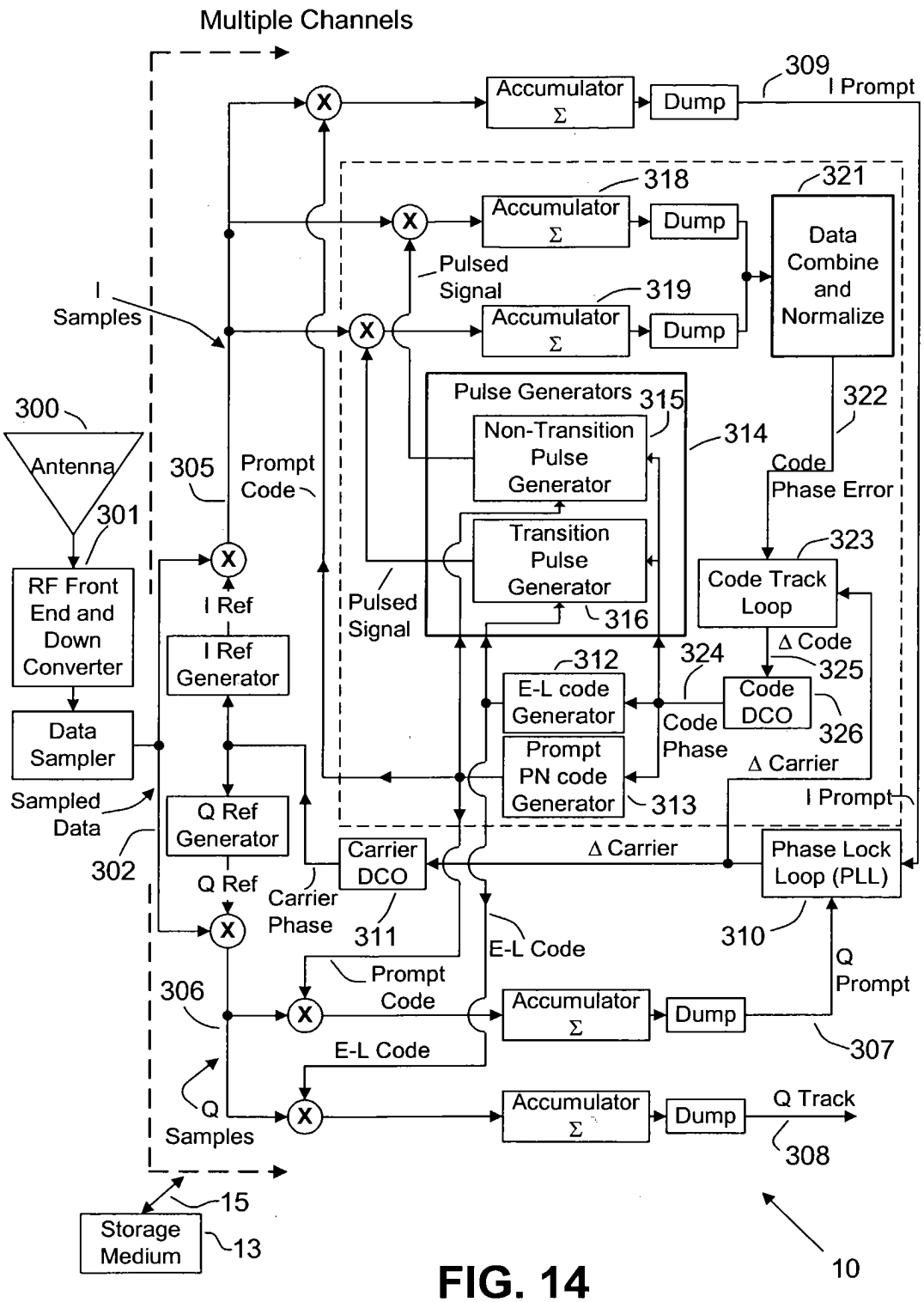



FIG. 13


Multiple Channels
309
I Prompt
Accumulator Σ
Dump
318
321
Accumulator Σ
Dump
Data Combine and Normalize
Pulsed Signal
I Samples
319
Accumulator Σ
Dump
Pulse Generators
315
322
300
Non-Transition Pulse Generator
314
Antenna
305
Prompt Code
Code Phase Error
301
Transition Pulse Generator
323
RF Front End and Down Converter
I Ref
Pulsed Signal
316
Code Track Loop
I Ref Generator
Δ Code
312
324
325
E-L code Generator
Code DCO
Data Sampler
Code Phase
326
Prompt PN code Generator
313
Δ Carrier
Sampled Data
Q Ref Generator
I Prompt
Δ Carrier
Phase Lock Loop (PLL)
302
Carrier DCO
Q Ref
Carrier Phase
311
E-L Code
310
Q Prompt
306
Prompt Code
Accumulator Σ
Dump
307
E-L Code
Q Samples
Accumulator Σ
Dump
Q Track
308
15
Storage Medium
13
10
FIG. 14

| Clock-Edge Events within the 1023 chip-length C/A code of GPS | | | | | | | |
|---|---|---|---|---|---|---|---|
| PRN | Total Non-Transitions (Nn) | | Total Level Transitions (Nt) | | Total L-H and H-L Polarity Transitions (Nt) | Total L-L and H-H Non Transitions (Nn) | Difference (previous two columns) |
| | L-L | H-H | L-H | H-L | | | |
| 1 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 2 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 3 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 4 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 5 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 6 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 7 | 272 | 271 | 240 | 240 | 480 | 543 | -63 |
| 8 | 240 | 239 | 272 | 272 | 544 | 479 | 65 |
| 9 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 10 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 11 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 12 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 13 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 14 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 15 | 272 | 271 | 240 | 240 | 480 | 543 | -63 |
| 16 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 17 | 272 | 271 | 240 | 240 | 480 | 543 | -63 |
| 18 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 19 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 20 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 21 | 272 | 271 | 240 | 240 | 480 | 543 | -63 |
| 22 | 240 | 239 | 272 | 272 | 544 | 479 | 65 |
| 23 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 24 | 272 | 271 | 240 | 240 | 480 | 543 | -63 |
| 25 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 26 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 27 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 28 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 29 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 30 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 31 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |
| 32 | 256 | 255 | 256 | 256 | 512 | 511 | 1 |

FIG. 15

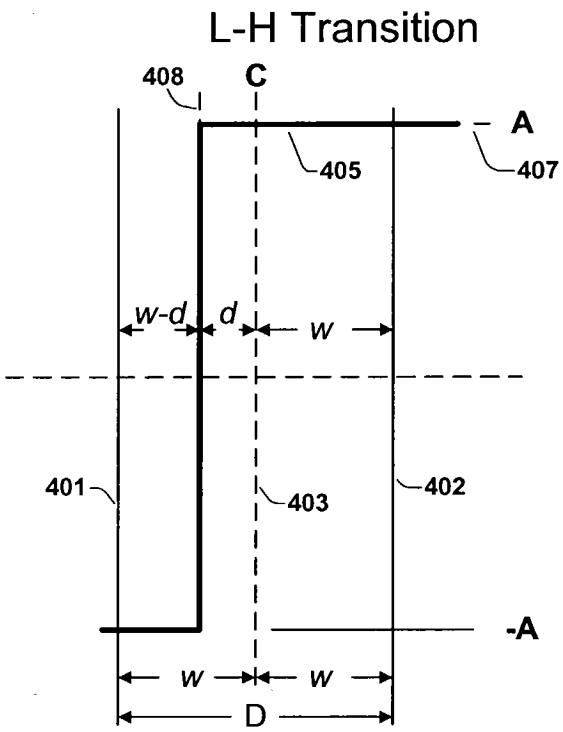



FIG. 16A

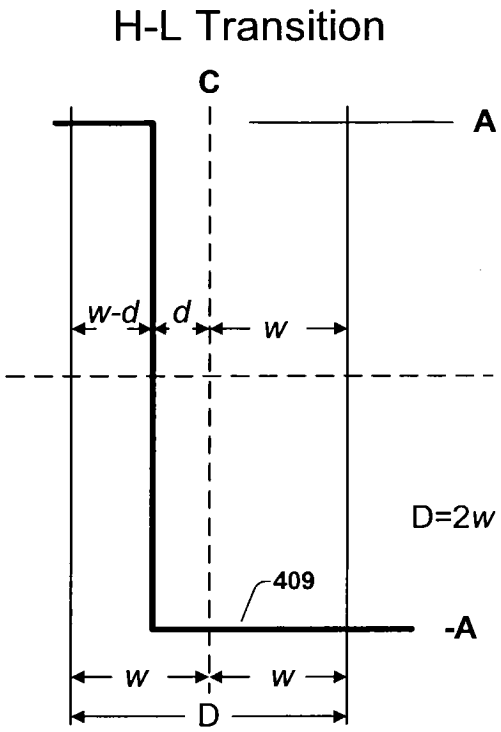



FIG. 16B

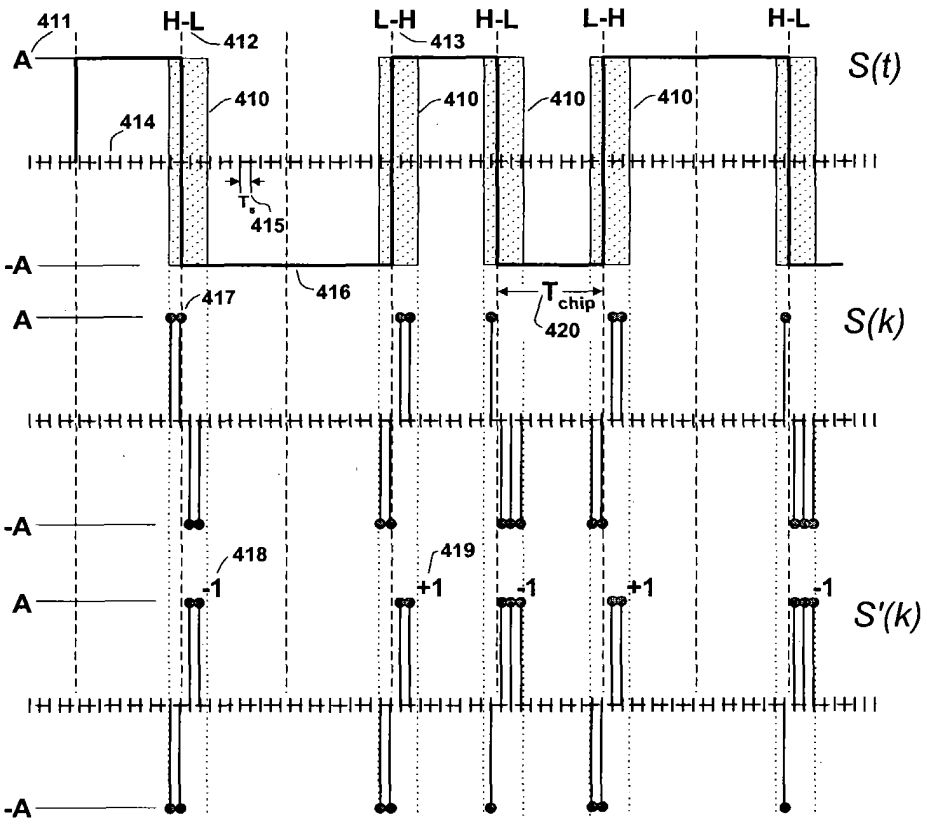



FIG. 17A

FIG. 17B

FIG. 17C

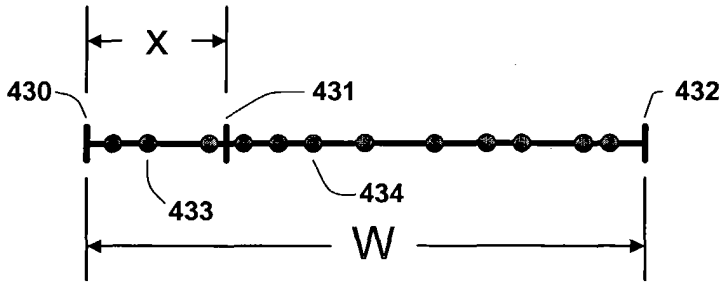



FIG. 18

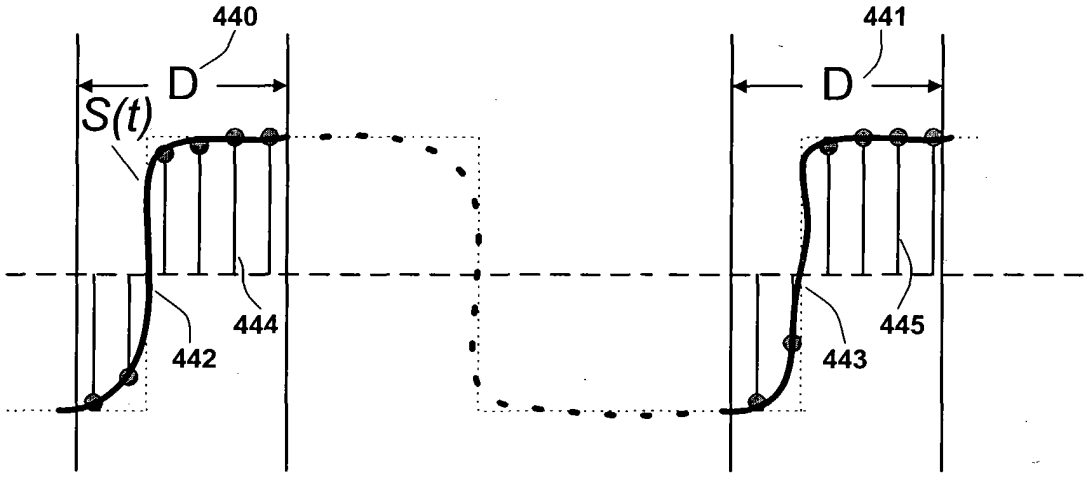



FIG. 19

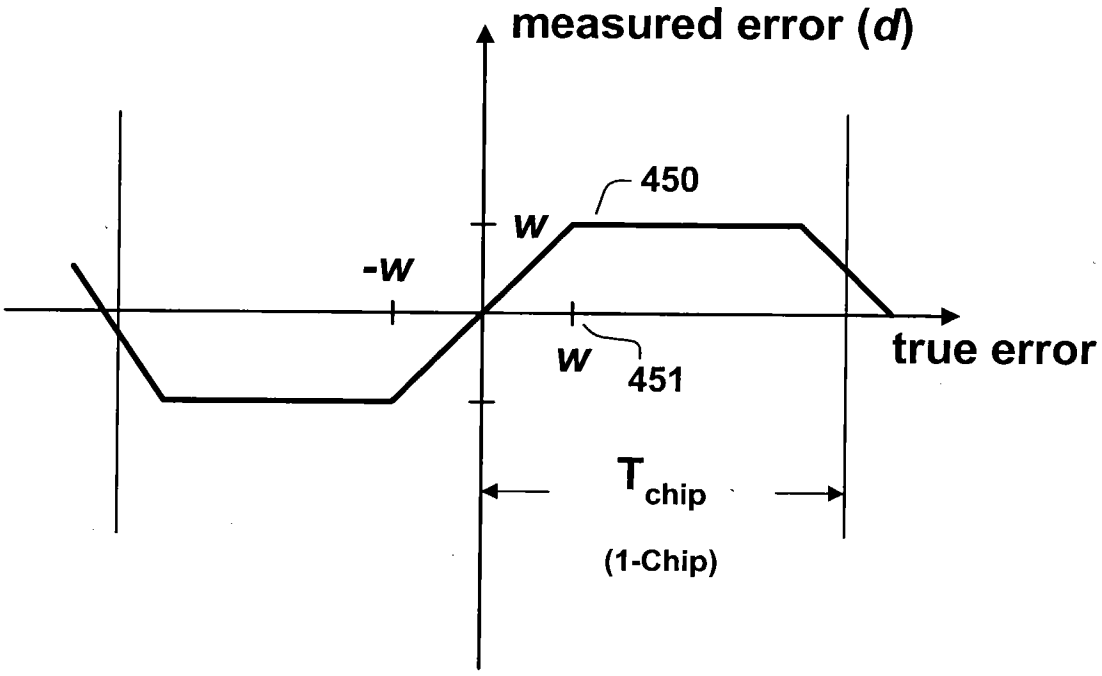



FIG. 20

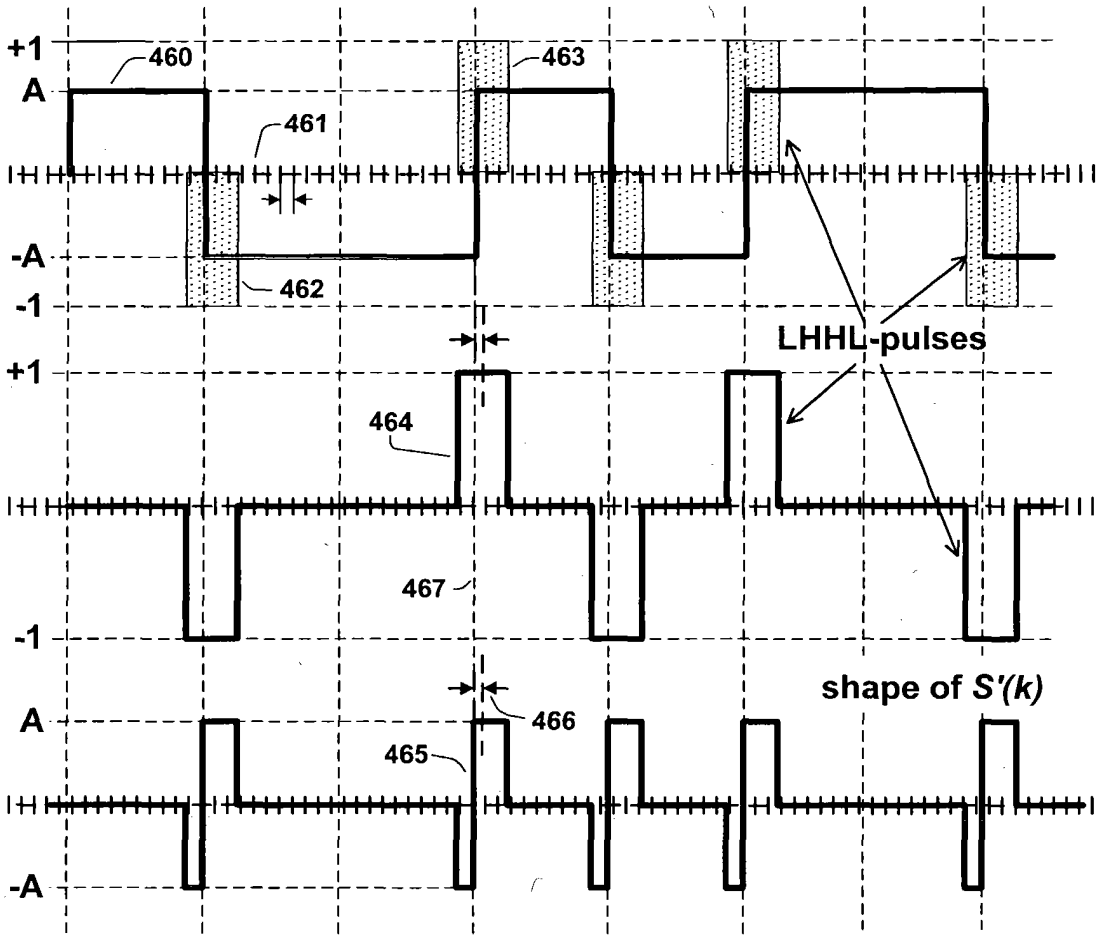

+1
A
-A
-1
460
461
462
463
LHHL-pulses
+1
464
467
-1
shape of S'(k)
A
466
465
-A

FIG. 21

FIG. 22A

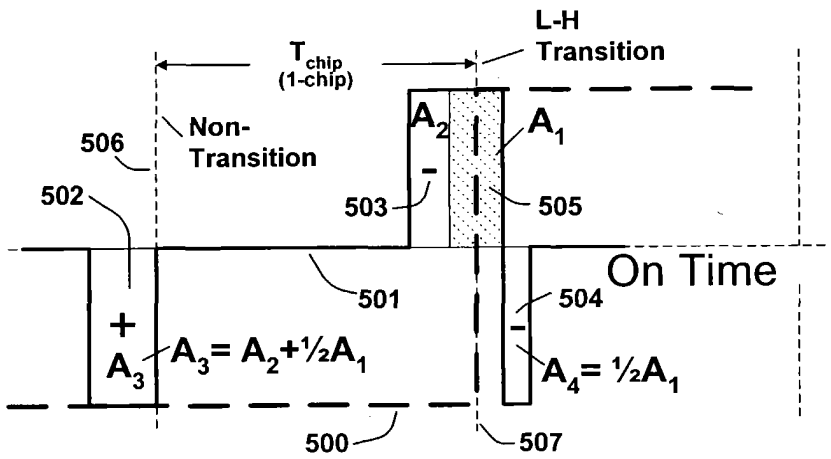



FIG. 22B

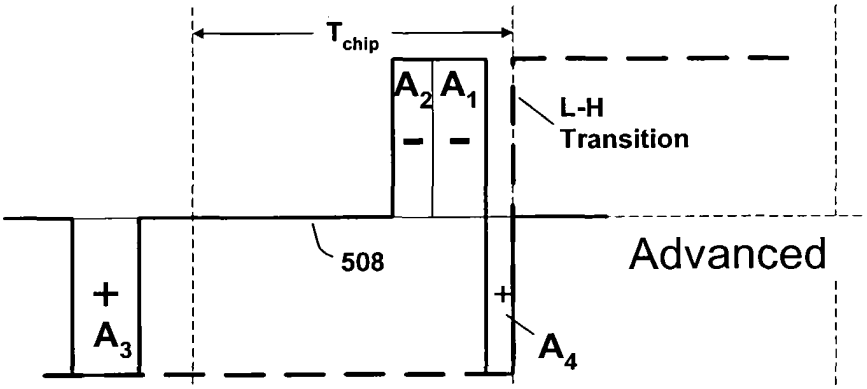



FIG. 22C

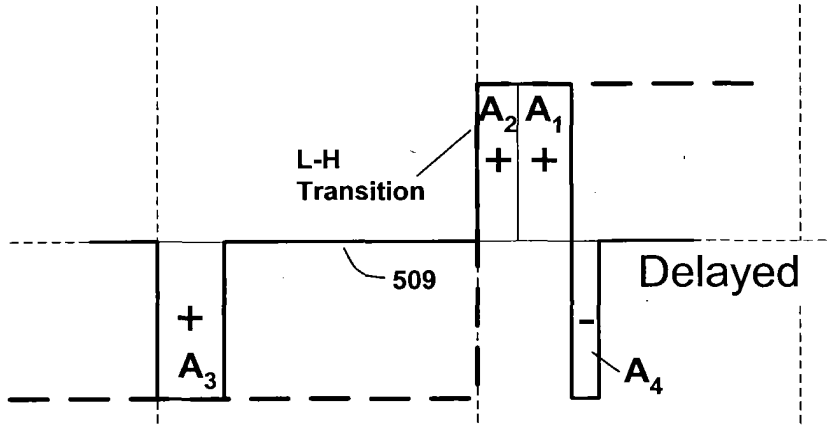


FIG. 23A

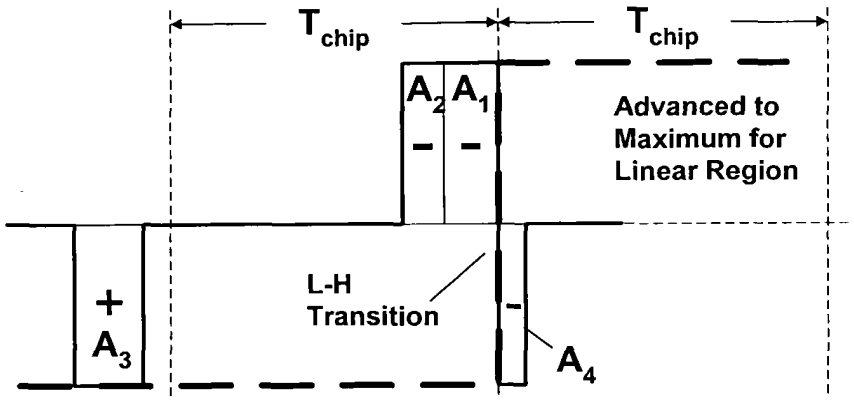



FIG. 23B

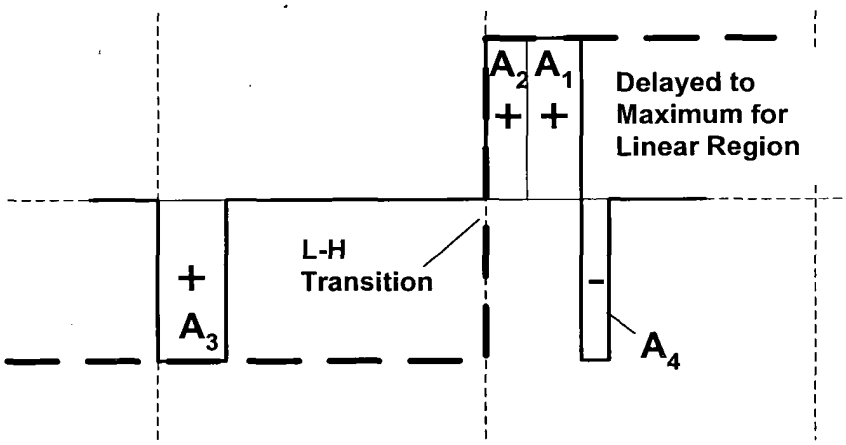


FIG. 24A

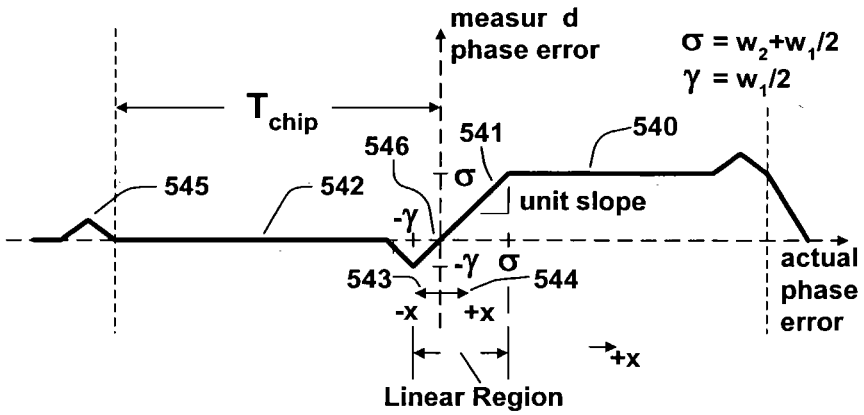



FIG. 24B

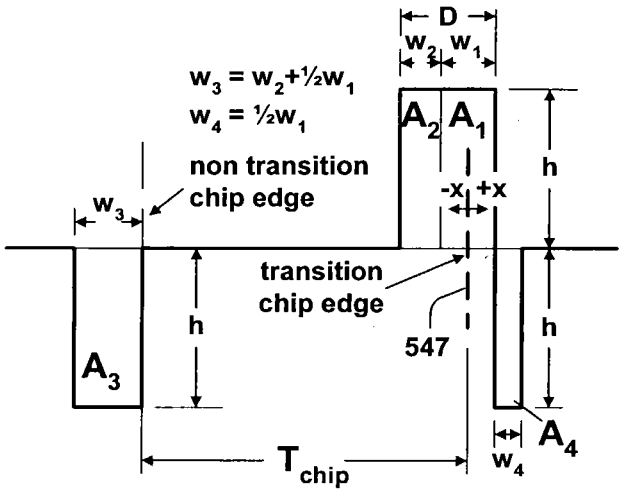


FIG. 25A

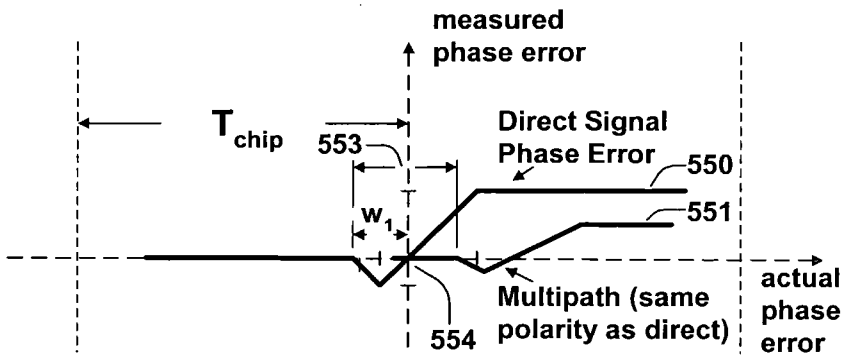



FIG. 25B

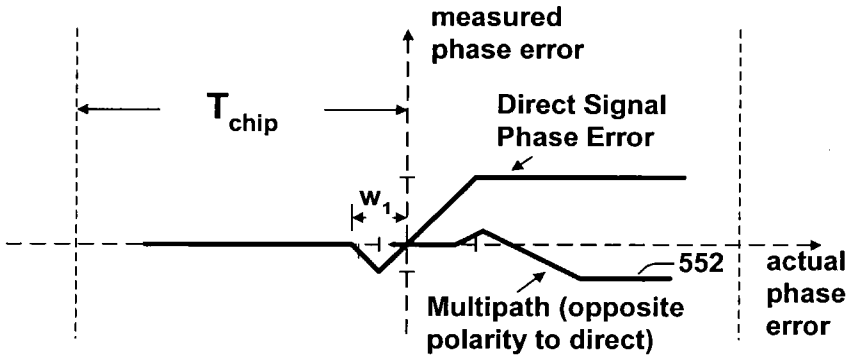


FIG. 26A

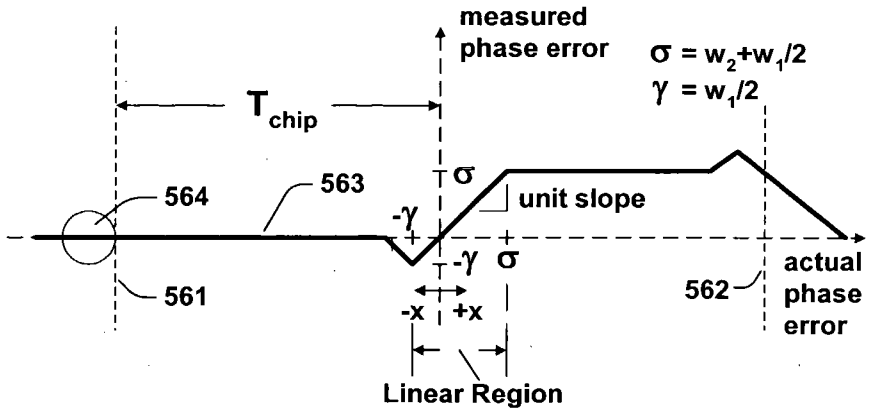
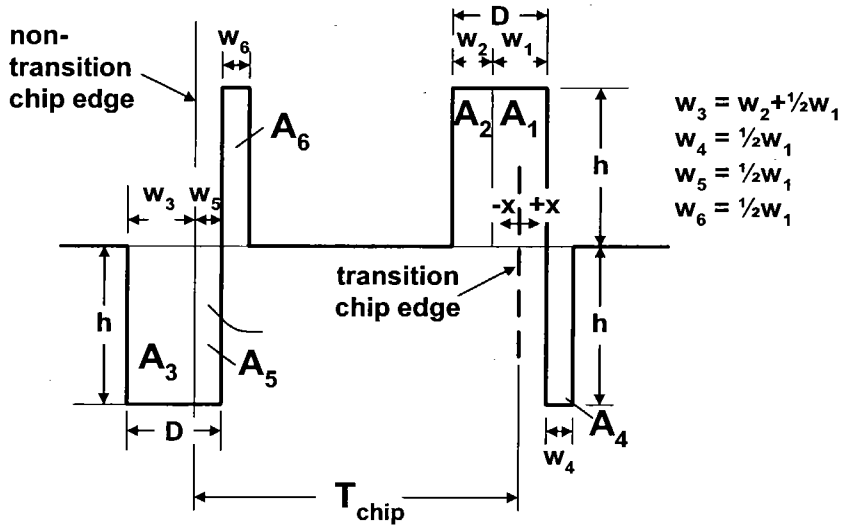



FIG. 26B



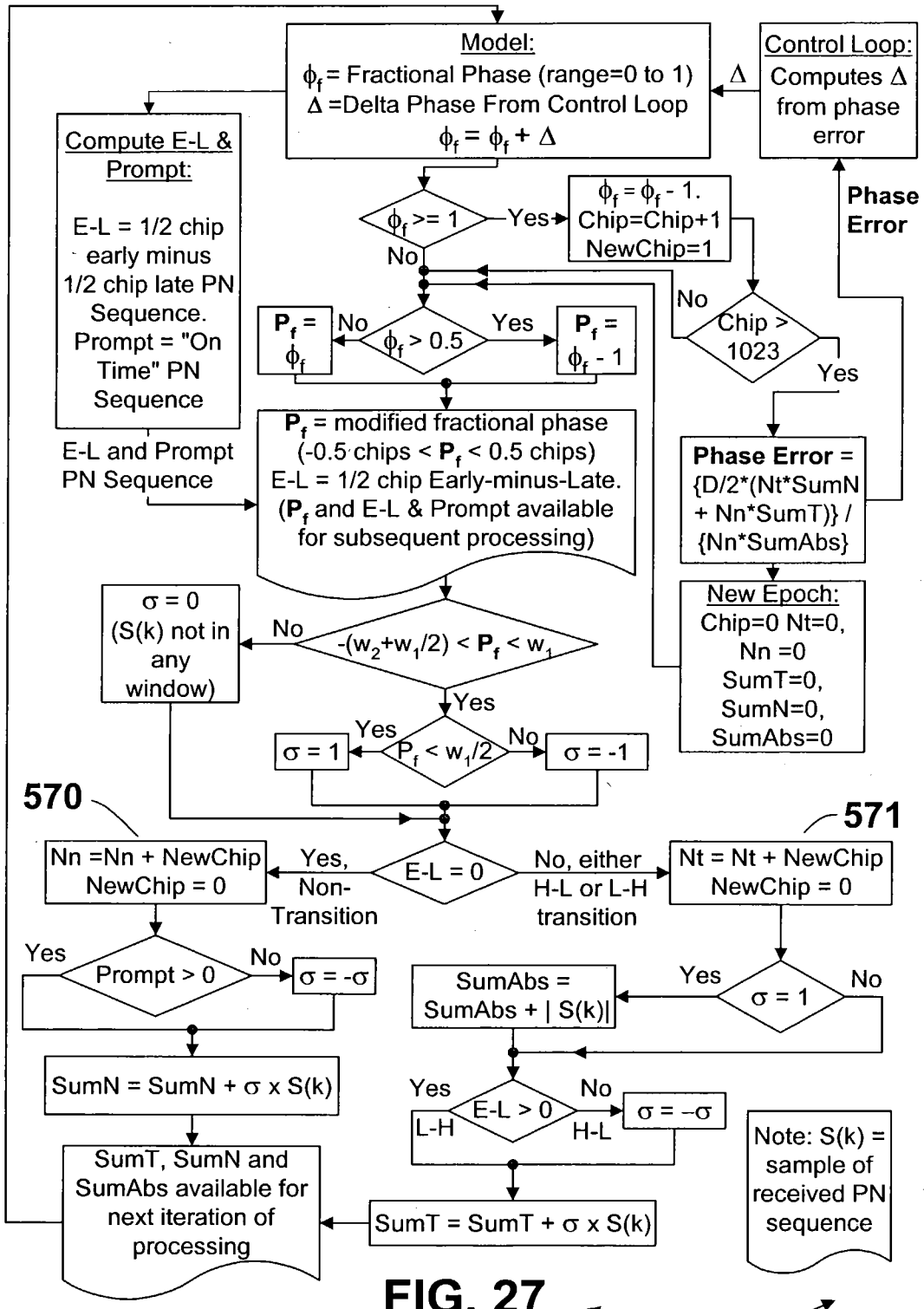

Model:
$\phi_f$ = Fractional Phase (range=0 to 1)
Δ =Delta Phase From Control Loop
$\phi_f = \phi_f + \Delta$
Control Loop:
Computes Δ from phase error
Δ
Phase Error
Compute E-L & Prompt:
E-L = 1/2 chip early minus 1/2 chip late PN Sequence.
Prompt = "On Time" PN Sequence
E-L and Prompt PN Sequence
$\phi_f >= 1$
Yes
No
$\phi_f = \phi_f - 1$.
Chip=Chip+1
NewChip=1
$P_f = \phi_f$
$\phi_f > 0.5$
$P_f = \phi_f - 1$
Chip > 1023
$P_f$ = modified fractional phase
(-0.5 chips < $P_f$ < 0.5 chips)
E-L = 1/2 chip Early-minus-Late.
($P_f$ and E-L & Prompt available for subsequent processing)
Phase Error = {D/2*(Nt*SumN + Nn*SumT)} / {Nn*SumAbs}
New Epoch:
Chip=0 Nt=0,
Nn =0
SumT=0,
SumN=0,
SumAbs=0
σ = 0
(S(k) not in any window)
$-(w_2+w_1/2) < P_f < w_1$
$P_f < w_1/2$
σ = 1
σ = -1
570
571
Nn =Nn + NewChip
NewChip = 0
E-L = 0
Yes, Non-Transition
No, either H-L or L-H transition
Nt = Nt + NewChip
NewChip = 0
Prompt > 0
σ = -σ
SumN = SumN + σ x S(k)
SumAbs = SumAbs + | S(k)|
σ = 1
E-L > 0
L-H
H-L
σ = -σ
SumT = SumT + σ x S(k)
SumT, SumN and SumAbs available for next iteration of processing
Note: S(k) = sample of received PN sequence

FIG. 27

100